

WHAT IS CLAIMED IS:

1                   1.       A wavelength router for receiving, at an input port, light having a  
2   plurality of spectral bands and directing subsets of the spectral bands to respective ones of a  
3   plurality of output ports, the wavelength router comprising:

4                   a free-space optical train disposed between the input port and the output ports  
5   providing optical paths for routing the spectral bands, the optical train including a  
6   transmissive dispersive element disposed to intercept light traveling from the input port, the  
7   optical train being configured so that light encounters the transmissive dispersive element at  
8   least four times before reaching any of the output ports.

1                   2.       The wavelength router recited in claim 1 further comprising a routing  
2   mechanism having at least one dynamically configurable routing element to direct a given  
3   spectral band to different output ports depending on a state of the dynamically configurable  
4   element.

1                   3.       The wavelength router recited in claim 2 wherein the dynamically  
2   configurable element comprises has a translational degree of freedom.

1                   4.       The wavelength router recited in claim 2 wherein the dynamically  
2   configurable element has a rotational degree of freedom.

1                   5.       The wavelength router recited in claim 2 wherein the routing  
2   mechanism has a configuration that directs at least two spectral bands to a single port.

1                   6.       The wavelength router recited in claim 2 wherein the routing  
2   mechanism has a configuration that results in at least one output port receiving no spectral  
3   bands.

1                   7.       The wavelength router recited in claim 2 wherein the routing  
2   mechanism includes a plurality of reflecting elements, each associated with a respective one  
3   of the spectral bands.

1                   8.       The wavelength router recited in claim 2 wherein:  
2                   the optical train further includes a lens;  
3                   the routing mechanism includes a plurality of dynamically configurable  
4   elements;

5 light coming from the input port is collimated by the lens, dispersed by  
6 passing twice through the transmissive dispersive element as a plurality of angularly  
7 separated beams corresponding to the spectral bands;

8 the angularly separated beams are focused by the lens on respective ones of  
9 the dynamically configurable elements; and

10 each dynamically configurable element has a plurality of states, each adapted  
11 to direct that dynamically configurable element's respective angularly separated beam along  
12 a desired one of a plurality of paths such that light leaving that dynamically configurable  
13 element is again collimated by the lens, passes twice through the transmissive dispersive  
14 element, and again focused by the lens on one of the output ports corresponding to the  
15 desired one of the plurality of paths.

1 9. The wavelength router recited in claim 1 wherein the input port is  
2 located at the end of an input fiber.

1 10. The wavelength router recited in claim 1 wherein the plurality of output  
2 ports are located at respective ends of a plurality of output fibers.

1 11. The wavelength router recited in claim 1 wherein the number of  
2 spectral bands is greater than the number of output ports.

1 12. The wavelength router recited in claim 1 wherein the transmissive  
2 dispersive element comprises a transmissive diffraction grating.

1 13. The wavelength router recited in claim 1 wherein the optical train  
2 further includes a reflective surface disposed to redirect light transmitted through the  
3 transmissive dispersive element back towards the transmissive dispersive element.

1 14. The wavelength router recited in claim 13 wherein the reflective  
2 surface is substantially flat.

1 15. The wavelength router recited in claim 13 wherein the reflective  
2 surface comprises optical power.

1 16. The wavelength router recited in claim 13 wherein the transmissive  
2 dispersive element and the reflective surface are comprised by an integrated element.

1           17.     The wavelength router recited in claim 1 wherein the optical train  
2 further includes a curved reflector disposed to intercept light from the input port, collimate  
3 the intercepted light, direct the collimated light toward the transmissive dispersive element,  
4 intercept light after it has passed twice through the transmissive dispersive element, focus the  
5 light, and direct the focused light along a path, with each spectral band being focused at a  
6 different point.

1           18.     The wavelength router recited in claim 17 wherein the optical train  
2 further includes a plurality of reflecting elements disposed to intercept the respective focused  
3 spectral bands to direct such respective focused spectral bands so as to encounter the curved  
4 reflector, pass through the transmissive dispersive element twice, again encounter the curved  
5 reflector, and encounter the respective output ports.

1           19.     The wavelength router recited in claim 1 wherein:  
2 the optical train further includes a first cylindrical lens for collimating light  
3 emanating from the input port in a first transverse dimension and a second cylindrical lens for  
4 collimating the light in a second transverse dimension that is orthogonal to the first transverse  
5 dimension; and

6 the transmissive dispersive element is configured to disperse the light in the  
7 first transverse dimension.

1           20.     The wavelength router recited in claim 19 further comprising a  
2 plurality of tiltable micromirrors in a focal plane of the first cylindrical lens, each such  
3 tiltable micromirror configured for intercepting a respective spectral band and directing that  
4 spectral band back toward the first cylindrical lens, wherein each spectral band is collimated  
5 in the first transverse dimension by passing twice through the transmissive dispersive  
6 element, focused in the second transverse dimension by the second cylindrical lens, and  
7 focused in the first transverse dimension by the first cylindrical lens, whereupon each spectral  
8 band is brought to a focus in both the first and second transverse dimensions at a respective  
9 position determined by the respective tiltable micromirror.

1           21.     A method for routing light having a plurality of spectral bands, the  
2 method comprising:  
3 receiving the light at an input port; and

directing the light along optical paths configured to route a subset of the spectral bands to respective ones of a plurality of output ports, each such optical path including propagation at least four times through a transmissive dispersive element.

22. The method recited in claim 21 wherein directing the light comprises steering each of the subset of the spectral bands to different output ports depending on a state of a respective dynamically configurable routing element.

23. The method recited in claim 22 wherein directing the light comprises:  
collimating the light from the input port;  
dispersing the collimated light by directing it twice through the transmissive dispersive element as a plurality of angularly separated beams corresponding to the spectral bands; and

focusing the angularly separated beams on respective ones of the dynamically configurable elements.

24. The method recited in claim 23 wherein steering each of the subset of the spectral bands comprises:

collimating light leaving the respective dynamically configurable routing element;

propagating the collimated light twice through the transmissive dispersive element to be focused on one of the output ports.

25. The method recited in claim 21 wherein the transmissive dispersive element comprises a transmissive diffraction grating.

26. The method recited in claim 21 wherein directing the light comprises reflecting light transmitted through the transmissive dispersive element back towards the transmissive dispersive element.

27. The method recited in claim 21 wherein directing the light comprises:  
collimating the light from the input port in a first transverse dimension;  
collimating the light in a second transverse dimension that is orthogonal to the first transverse dimension; and

dispersing the light in the first transverse dimension with the transmissive dispersive element.

1                   28.    A wavelength router comprising:  
2                   means for receiving light having a plurality of spectral bands;  
3                   means for directing the light along optical paths configured to route a subset of  
4 the spectral bands to respective ones of a plurality of output ports, each such optical path  
5 including propagation at least four times through a transmissive light-dispersing means.

1                   29.    The wavelength router recited in claim 28 wherein the means for  
2 directing the light comprises means for steering each of the subset of the spectral bands to  
3 different output ports depending on a state of a respective dynamically configurable routing  
4 means.

1                   30.    The wavelength router recited in claim 29 wherein the means for  
2 directing the light comprises:  
3                   means for collimating the received light;  
4                   means for dispersing the collimated light by directing it twice through the  
5 transmissive light-dispersive means as a plurality of angularly separated beams corresponding  
6 to the spectral bands; and  
7                   means for focusing the angularly separated beams on respective ones of the  
8 dynamically configurable routing means.

1                   31.    The wavelength router recited in claim 30 wherein the means for  
2 steering comprises:  
3                   means for collimating light leaving the respective dynamically configurable  
4 routing means; and  
5                   means for propagating the collimated light twice through the transmissive  
6 light-dispersing means.

1                   32.    The wavelength router recited in claim 28 wherein the means for  
2 directing the light comprises means for reflecting light transmitted through the transmissive  
3 light-dispersing means back towards the transmissive light-dispersing means.